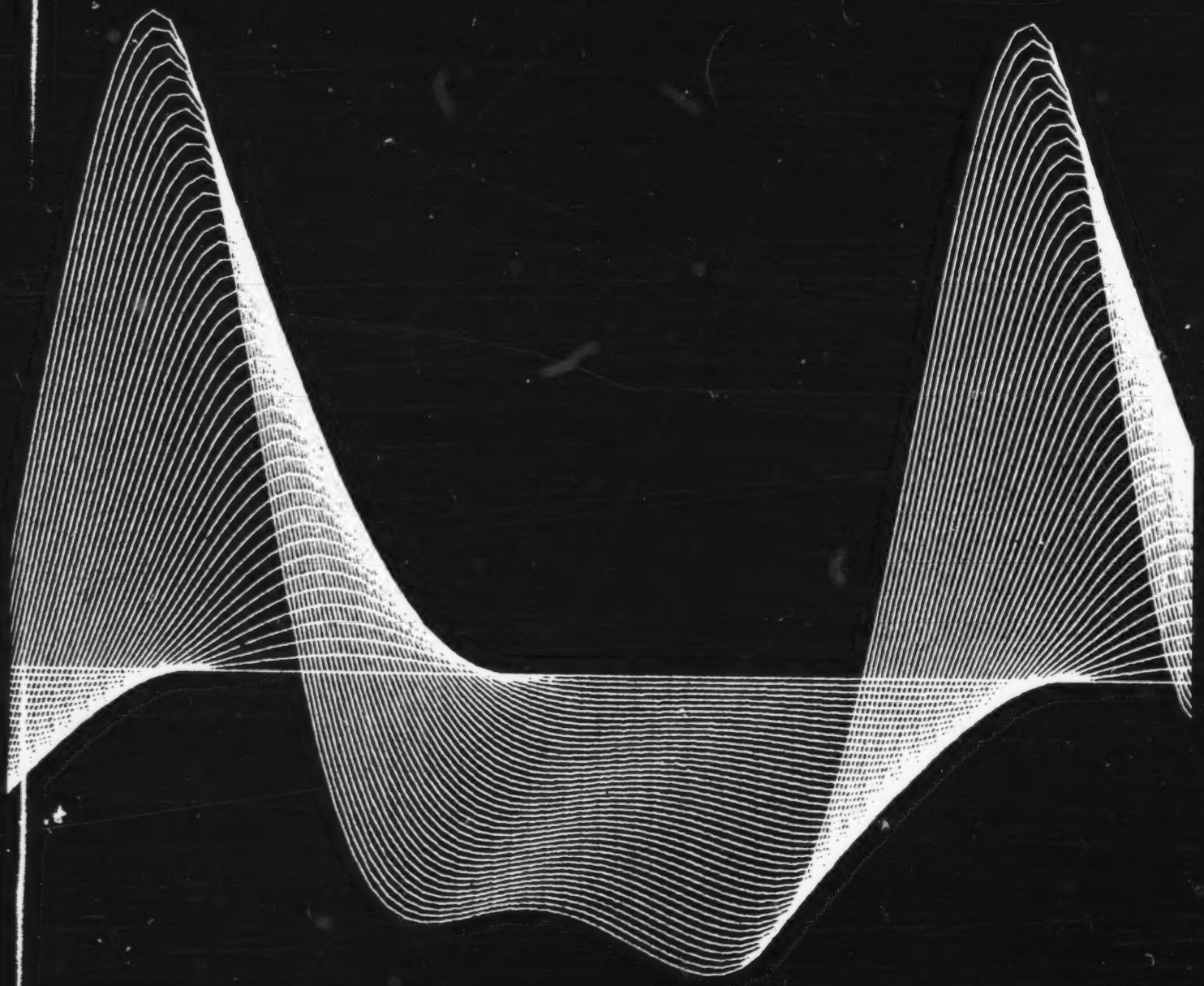
Alberta Research Council Annual Report 1982



Alberta Research Council Annual Report 1982

The Alberta Research Council is a Crown Corporation dedicated to actively promoting responsible economic development in the Province of Alberta through a broad range of research in science and technology. Over 500 employees, among whom are 220 professional scientists and engineers, work in Edmonton, Calgary, Red Deer, Nisku and Lethbridge.

The Alberta Research Council is the oldest and largest provincial research organization in Canada, and is an international leader in energy resources research and weather modification research. The five major research programs are industrial and engineering research, frontier sciences thought to be of future economic benefit to Alberta, oil sands, coal, and natural resources.

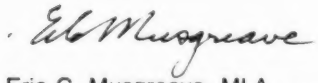
To respond as effectively as possible to the many and varied requests for research assistance from the public and private sectors, the Alberta Research Council has organized its research programs into a matrix system. Each program is a collection of related research activities carried out in several departments. This annual report is presented according to this system.

Letter of Transmittal

To The Honorable Peter Lougheed
Premier of the Province of Alberta

In accordance with the requirements of the Alberta Research Council Act, I have the honor to present to you the Annual Report of the Alberta Research Council for the calendar year 1982.

Respectfully submitted,



Eric C. Musgreave, MLA
Chairman, Alberta Research Council

March 1983

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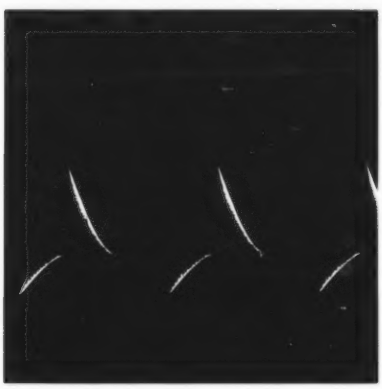

The cover shows the propagation of error (in time) between a numerical solution and a known solution to a Korteweg-deVries Burgers equation. This equation enables error propagation due to the following phenomena to be examined: (i) convective nonlinearity, (ii) dispersion, and (iii) diffusion. A second order scheme was used for the numerical calculation. Analysis of error propagation aids in understanding large oil sand reservoir simulations done in the Oil Sands Research program.

Copies available from:

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Chairman's Message

Alberta is well known for its active support of science and technology. In fact, Alberta is a leader among Canadian provinces for encouraging research and development as we strive to diversify our economy. I am proud, therefore, to regard the Alberta Research Council as an important and effective part of our provincial industrial strategy.

It is also a great pleasure for me to have served another year as Chairman of such an active Board of Directors. I am grateful for each member's contribution, but I particularly would like to acknowledge the service of Mr. Jack Cookson, former Minister of Environment, who retired from the Board at the time of the provincial election in November.

The Board was saddened by the death in September of one of its members, Dr. John Forster, who was Dean of Graduate Studies and Research at the University of Alberta. We will miss his valuable contribution.

Long-time Board member, Dr. Robert M. Hardy, has been honored by the engineering community through the establishment of the Robert M. Hardy Engineering Enrichment Fund at the University of Alberta.

I also congratulate a Board member, Dr. Clement W. Bowman, Chairman and Chief Executive Officer of the Alberta Oil Sands Technology and Research Authority (AOSTRA), for his election as President of the Chemical Insititute of Canada, and another, Mr. Marshall M. Williams, President and Chief Executive Officer of TransAlta Utilities Corporation, on becoming President of the Canadian Electrical Association.

Finally, I welcome a new member to the board, the Honorable Dick Johnston, Minister of Advanced Education, who brings an added dimension to our Board and will provide a productive interaction with universities.

Eric C. Musgreave, M.L.A.
Chairman, Alberta Research Council

President's Report

Closer liaison and collaboration with industry in research and development was a high priority goal of the Alberta Research Council in 1982. We realized a great deal of that goal during the year and continued to enjoy a good working relationship with government departments and agencies.

Furthermore, the strategies and operating mechanisms described in our Long Range Plan three years ago reached a level of 'maturity' as we continued to implement them. Progress in this area produced greater cohesion in research operations throughout the Alberta Research Council allowing us to reach an increased level of productivity.

Although the sudden change in the province's economic climate has forced us to readjust some of our research programs, the government has maintained its commitment to promoting research and development in Alberta. A significant change was development of a pilot project for research ventures with industry to start early in 1983.

This report is devoted mainly to our major research programs, but I would like to present some overall highlights of the year.

Over the past three years, the Alberta Research Council devoted a great deal of attention to establishing an effective management structure and administration system. I am pleased to report that we now have a set of operating policies and procedures that provide a reasonable base for a responsible operation. Also, with a group of competent managers we now have a research organization that is managed in a professional way.

In keeping with our efforts to develop closer liaison with industry, the Industrial and Engineering Research Division was reorganized. Starting from a group of relatively unrelated departments, we now have a system that can respond to the needs of the private sector. It can also initiate collaborative projects with industry. Furthermore, this division became responsible for coordinating and administering the program of research ventures with industry to start in the coming year.

In the Frontier Sciences program, the Alberta Research Council was fortunate to hire a world class chemist as a Research Fellow, Dr. Denis Ballard, to head surface chemistry research. In biotechnology, the low temperature biology project underwent a significant expansion and the joint venture project with BIO LOGICALS inc. of Ottawa was started, but more conservatively, than initially projected. The Research Committee also agreed to pursue a new area of research on the theme of man/computer/machine, another area that could prove of long-term economic benefit to Alberta.

Following the Alberta Research Council's signing of a joint venture agreement with the Alberta Oil Sands Technology and Research Authority (AOSTRA) in 1981, the joint venture established in 1982 a program allowing industry to access information from the joint venture research. Despite the downturn in the economy, some companies have subscribed to the program, and despite the cancellations of some major oil sands projects, the Alberta Research Council recorded an increase in oil sands research contracts with industry.

The Alberta Research Council signed a three-year agreement with Alberta Energy and Natural Resources on a joint coal research program. Coal research has produced some positive results during the year, but activity has been limited because of insufficient research facilities during the installation of equipment in the high pressure facilities at Nisku.

Excellent collaboration with Alberta Energy and Natural

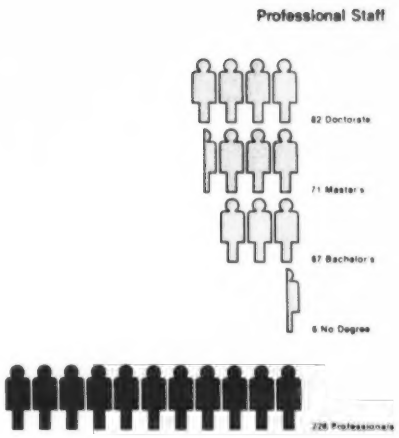
Resources, Alberta Environment and Alberta Agriculture has helped the Natural Resources program to progress effectively towards projections of our Long Range Plan. A good example of how well the matrix structure of our research programs has worked is the contribution of the Alberta Geological Survey to the Oil Sands and Coal Programs. The Geological Survey Department also contributed to two international conferences, and its organization of an open house style of conference was a good demonstration of how the Alberta Research Council effectively interfaces with the public and private sectors. Under a joint venture project with INTERA Environmental Consultants Ltd., the Alberta Research Council successfully tested its new research aircraft as part of the cloud seeding project during the summer.

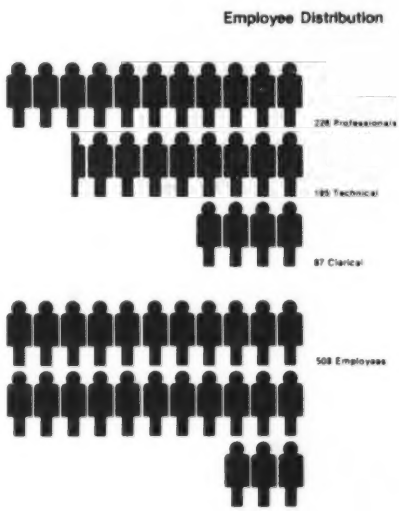
I am pleased to report that the Alberta Research Council has made great progress with its facilities in 1982. In the past three years our facilities have been either inadequate or under renovation, which has hindered our progress to some extent. Renovations at the Campus Building were completed and laboratories were made fully operational. The temporary research facilities at Nisku were largely completed, and construction started on the permanent facilities at Devon. Construction also began on the facilities, in south Edmonton, to become our new permanent head office and to provide laboratory space for more effective support of Alberta industry.

Among the major highlights of our staff during the year was the appointment of Dr. Guy Goyer as Research Fellow. Dr. Goyer, who is former Head of the Atmospheric Sciences Department, started a research project on lightning. As mentioned above, Dr. Denis Ballard became our first Research Fellow from outside the organization. I am also pleased to acknowledge the appointment of three employees as Fellows of the Chemical Institute of Canada: Dr. Sujit Chakrabartty, Dr. Zac George and Dr. Karlo Schulz.

Finally, it is once again with great pleasure that I acknowledge the great support of our Board of Directors.

Gilles G. Cloutier
President





Industrial & Engineering Research

The Alberta Research Council's Industrial and Engineering Research program was redefined and restructured in 1982 to meet more effectively its new role and to respond more efficiently to the needs of Alberta's industrial sector. This reorganization also resulted in major changes to the division in which most of this program's research activities take place.

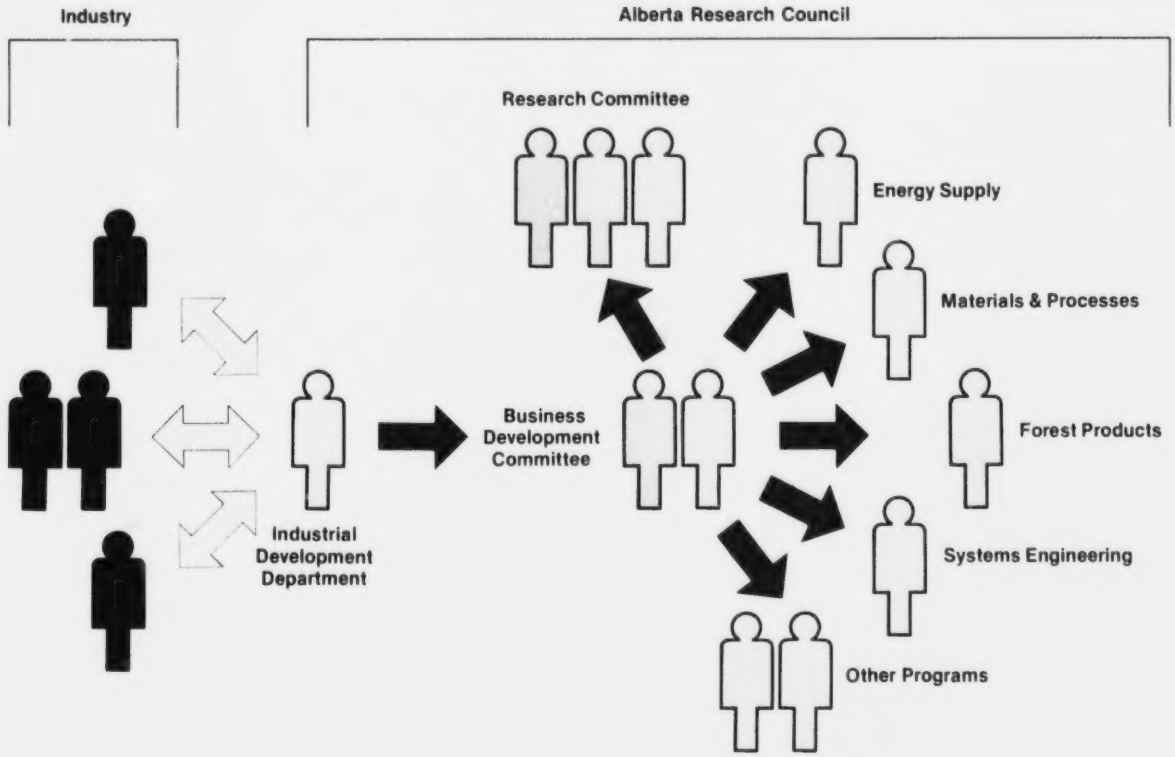
For many businesses the first point of contact at the Alberta Research Council will now be the Industrial Development Department, formerly the Industrial and Engineering Services Department. Contact with this group could result in a simple solution to a small problem given over the telephone, or it could lead to a multi-year research contract or joint venture with one or more of the major research programs.

Any problem or enquiry beyond the scope of the Industrial Development Department's short-term problem-solving capacity is referred to a Business Development Committee, which consists of researchers who decide how a given problem can best be handled, ensuring the most effective allocation of resources.

Medium-term projects, lasting weeks or months, can be referred by the committee to one of several other sub-programs: Energy, Supply, Materials and Processes, Forest Products, Systems Engineering, or to other major research program areas within the Alberta Research Council.

Longer-term contracts or joint ventures, calling for a major commitment of Research Council manpower and facilities, are usually referred to the Research Committee, consisting of senior managers of all the major research programs.

A rotary kiln used in research work on the recovery of pure iron from low-grade iron ores. The process was developed for iron deposits found in the Clear Hills area of Alberta.



Industrial Development

The staff in the Industrial Development subprogram are the main interface between the Alberta Research Council's research sectors and Alberta's business community. They are responsible for publicizing services and capabilities for solving short-term problems, supplying technical assistance and technical information, and also putting Alberta's small industrial entrepreneurs in contact with those parts of the Alberta Research Council most able to assist them. The staff of this subprogram provide industrial assistance over the short term — from an hour to two or three days. This service, mostly free of charge, includes a telephone aid line, technological and engineering assistance with industrial problems, applications for grants, access to computerized information systems, and advice on procedures for standardizing or certifying a product.

Over 2400 enquiries for technical information were handled in 1982. Private citizens, representatives of all sizes of businesses and of government departments and agencies were supplied with information on available technology on such things as glass blowing, nuclear batteries, peanut brittle packaging technology, industrial microwave ovens, recycling of plastics, and methods for repairing cracked windshields. In-house files and library services, as well as access to international databases on scientific and technical information, helped provide complete answers in most cases or referrals for further information. The National Research Council was a major sponsor of this information service through its Industrial Research Assistance Program (IRAP), which is administered by the Research Council within Alberta; one result was the placing of 17 students into manufacturing companies to work on designated projects.

The Alberta Research Council responded to over 1300 enquiries from Alberta manufacturers with advice on design of production systems and plant layout. It used both laboratory and on-site investigations in response to over 380 enquiries in mechanical engineering, handling cases such as information on overload protection of electric motors, design of wood stoves, calculation of roof snow loads and design of door frames. The over

550 enquiries in materials engineering included fatigue failure of portable heater mounts, aluminum gas pipe failure and corrosion on thermoelectric components.

Energy Supply

The Energy Supply subprogram covers studies and applications of solar and wind energy, and has planned for activities in electricity-related research. The Alberta Research Council's Electricity Working Group made proposals on electricity supply, which remain under review. A second Electricity Working Group, composed of representatives from industry, government, universities and the Alberta Research Council, studied potential developments in high technology of interest to Alberta. It submitted a proposal covering the long-term needs of Alberta in terms of the resources required by the developing industrial sector. This proposal is under active consideration.

The Solar and Wind Energy Research Program (SWERP) is managed by the Alberta Research Council on behalf of the Alberta/Canada Energy Resources Research Fund (A/CERRF). The project includes a network of solar and wind energy monitoring stations throughout Alberta. Results of this monitoring system contributed to a continuing evaluation of the total potential of this renewable energy resource in the province.

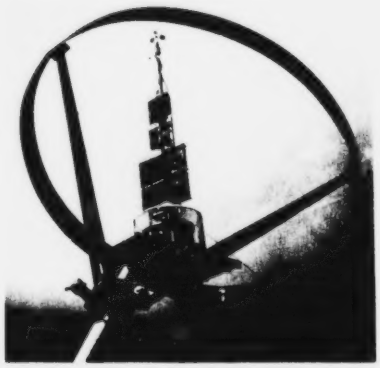
The SWERP staff continued work on a project to monitor and demonstrate the performance of small wind turbines for water pumping applications. This latter project is funded jointly by A/CERRF and Alberta Agriculture's Farming for the Future.

Researchers also analyzed wind energy data from 140 weather stations across Canada, under a contract for Environment Canada that will use the data to assess the wind power potential at each weather station.

Materials and Processes

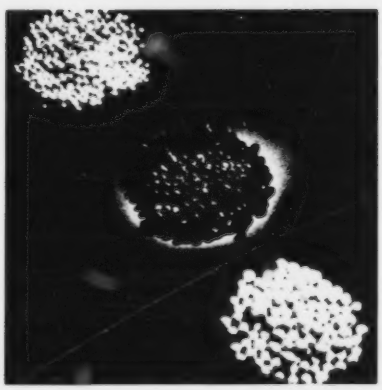
Under the Materials and Processes subprogram, a wide variety of physical and chemical tests can be carried out on materials and products to help Alberta manufacturers solve their problems. Manufacturing, construction and chemical processing are three of the industry sectors the Alberta Research Council assisted during 1982, with over 500 tests. Clients were assisted with enquiries about the safety and usage of certain cleaning agents, the problem with a particular type of paint, how quickly and completely water vapor passed through certain types of plastic film, and the corrosiveness of fire retardants developed for cellulose insulation, to name a few. In all cases the problems were analyzed and the results reported to the client.

A major problem with irrigation canals in southern Alberta is the significant loss of water to seepage into the ground, creating soil zones with high concentrations of soluble salts where little or no vegetation will grow. A solution to that seepage problem could be a strong, durable type of plastic sheet to line the bottom and sides of each canal. The Alberta Research Council tested a plastic material proposed for the irrigation project on behalf of Alberta Environment and has assisted them with the specification and selection of a specific material suitable for use in lining the canals.



TOP: One of the solar energy monitoring stations in an Alberta network contributes to evaluation of solar energy's potential in the province and supplies data for monthly solar and wind energy data summaries.

BOTTOM: The strength of plastic material for lining irrigation canals is tested for suitability. Linings are used to prevent water from seeping out of the canals and building up high concentrations of soluble salts in the soil.



TOP: Hydrogen can be separated when off gases from ammonia or petrochemical plants are passed through this specially prepared hollow fiber membrane.

BELOW: New catalyst (right), used catalyst (middle), and catalyst regenerated (left) in the patented Claus Catalyst Regeneration process, which could reduce costs in the removal of hydrogen sulfide from sour gas.

Large iron deposits in the Clear Hills area of northwestern Alberta have not been exploited because they contain only 30 to 35 percent iron and cannot be upgraded using standard mineral processing techniques. The Alberta Research Council developed a process for extracting pure iron from ore, using chemical means. This Grain Enlargement Process produces iron that can be used in electric furnace steel production.

In Alberta there will be a demand for hydrogen for heavy oil and oil sand bitumen upgrading as well as coal liquefaction and gasification. The Alberta Research Council has found that by passing purge gas from ammonia plants, or petrochemical plant recycle gas, through a specially prepared membrane, the hydrogen can be separated from these off gases, returned to the process as a feedstock, or the excess made available for other petrochemical processes. This process is adapted from the Alberta Research Council's membrane process developed to separate helium from natural gas. Pilot plant tests are planned after the laboratory study is complete. If the larger scale tests are successful, the process could prove a great benefit to the petrochemicals industry.

In heterogeneous catalysis studies, a senior staff member was seconded for five months by the Alberta Oil Sands Technology and Research Authority (AOSTRA) to Venezuela's National Petroleum Research Center, INTEVEP. A desulfurization process developed at the Alberta Research Council was found to be applicable to petroleum coke derived from Venezuelan heavy oil. This treatment enables the coke to be burnt as fuel without excessive sulfur dioxide emission.

Also during the same visit, Venezuelan bauxite was examined as an alternative catalyst to the more expensive, imported activated alumina in the Claus conversion process. This Claus process converts hydrogen sulfide, the 'sour' component of sour gas, to elemental sulfur, which can be either stored without harm to the environment or used to make sulfuric acid for industrial chemical production. This work complemented studies undertaken at the Alberta Research Council that have led to a Claus Catalyst Regeneration procedure with commercial potential. A joint development on the latter involving the Alberta Research Council and Catalyst Recovery Canada Limited of Medicine Hat is underway.

Forest Products

The Alberta Research Council, supported by Alberta Energy and Natural Resources and Alberta Economic Development, has developed a Forest Products subprogram, to examine potential products and manufacturing methods in support of the Alberta forest products industry.

Researchers completed the preliminary design of a machine for measuring stress limits of structural wood panels, developed an optimization model for waferboard production, and evaluated poplar-based panel board options for Alberta. They demonstrated the feasibility of producing shingles from Alberta jackpine and aspen. Furthermore, the Alberta Research Council established jointly with the University of Alberta a forest products laboratory at the university.

Other projects in progress during the year included: technical assistance to the Western Plywood Manufacturers' Association on allowable unit stresses for spruce plywood; joint feasibility projects with Canadian Forest Products Ltd. on fire impregnation, bleaching and gluing aspen; and a study using granulated aspen bark as a filler for plastics in molded plastic products.

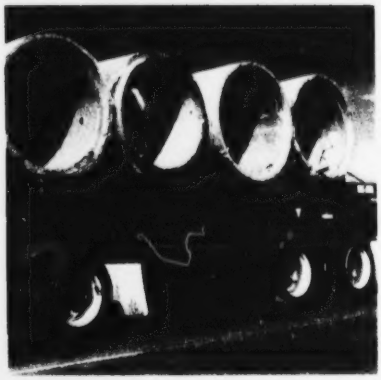
Systems Engineering

The Systems Engineering subprogram covers research in civil engineering areas, such as construction of roads, bridges, and other structures along the province's waterways.

The damaging effects of truck loadings on pavements depends, in part, on axle spacing. To evaluate these effects for Alberta Transportation, the Alberta Research Council has, for eight years, been measuring critical pavement strains and deflections under a wide range of truck axle loading configurations on an instrumented pavement structure in the field. A mini-computer in a vehicle enables engineers to collect instantaneous and continuous data as a truck crosses multiple transducers embedded in the pavement. Results of detailed analysis carried out on these measurements are being incorporated into provincial motor transport regulations and are also being considered in the development of interprovincial truck weight and dimension standards.

The Alberta Research Council is also contributing to the development of a pavement management system for the province. The pavement inventory database, developed for Alberta Transportation, contains information gathered on subsoil type, pavement construction composition, traffic, and measured outputs of strength, ride quality and surface condition. The data have been gathered over 20 years from 3500 inventory sections of the primary highway system. This historical database allows engineers to develop mathematical models for predicting performance changes with time and for assessing what remedial measures are required, and when. It is a major contribution to the efficient maintenance of Alberta's large and complex highway network.

The pressure of massive ice floes grinding their way past bridge piers during spring breakup is of concern to engineers who must design the piers to withstand these forces. For over 15 years, the Alberta Research Council has been monitoring for Alberta Transportation ice forces on the piers of two bridges, each with a different type of pier configuration. Analysis of data on the loads on these piers at the time of the spring breakup, combined with vibration data from controlled loading experiments, has allowed engineers to develop mathematical models for describing the response of various types of piers. From these prototype measurement systems, engineers can develop relatively light and inexpensive equipment for monitoring the peak loads on selected bridge piers throughout the province. Unique to North America, these systems developed by the Alberta Research Council and Alberta Transportation have produced data now included in recent revisions to the Canadian structural design codes to effect further economies in the design of bridge piers.



TOP: The effects of truck axle configurations and loadings on pavement strains and deformations have been under study for Alberta Transportation.

BOTTOM:Measurements of ice loads on bridge piers have produced data incorporated in recent revisions to the Canadian structural design codes.

Frontier Sciences

The Frontier Sciences Research program includes new fields considered to offer long-term opportunity for Alberta. They are among the fastest-growing areas of scientific research. The two subprograms active during 1985 were Catalysis and Surface Chemistry, and Biotechnology.

Catalysis and Surface Chemistry

Catalysis research projects in this subprogram are expected to contribute to the petrochemicals industry. Following earlier studies in zeolite catalysts, some current research activity is concentrating on the design and testing of new catalysts.

Unsaturated hydrocarbons, such as ethylene or propylene, are important chemical feedstocks in the petrochemical industry. When saturated hydrocarbons are required, propane for example, unsaturates can be treated with hydrogen (hydrogenation). Unsaturates may also be upgraded by treatment with both hydrogen and carbon monoxide (hydroformylation) to produce a variety of materials used as solvents, plastics, plasticizers and surfactant agents. Work at the Alberta Research Council is concentrating on the hydroformylation process.

Researchers have found that soluble catalysts with two metal centers — in this case two rhodium atoms — linked together by a common ligand acted more efficiently than catalysts in which the metal centers were unlinked or independent. Such discoveries are expected to lead to greater efficiencies in the petrochemical industry.

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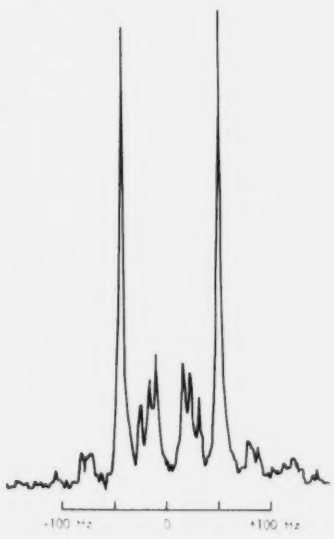


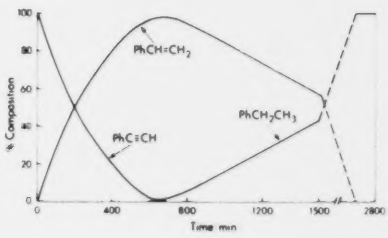
For either of these processes to work efficiently, catalysts may be either solids (heterogeneous catalysts), or soluble compounds. The soluble catalysts used are composed of a central metal atom and modifying organic groups called 'ligands.'

During 1982 scientists at the Alberta Research Council found that catalysts that contained two metal centers linked together by a common ligand acted more efficiently than catalysts in which the metal centers were unlinked or independent. For instance, they prepared a series of entirely novel catalysts of high activities in which two rhodium atoms linked together and proved effective as catalysts. These results have given scientists a further insight into the way both soluble and heterogeneous catalysts work, and could help improve the design of catalysts for more efficient use in the petrochemicals industry.

TOP LEFT: X-ray crystallography reveals the structure of the cation, or positively charged ion, present in a catalytic complex under investigation.

LEFT: From this spectrum of the cation illustrated above it, the interactions of the phosphorus and rhodium components can be evaluated.

BOTTOM: These are the results of adding hydrogen to phenylacetylene (hydrogenation) to produce sequentially styrene then ethylbenzene using the catalytic complex already illustrated. The same result was also obtained using different anions (negative ions), showing that only the cation was important in the catalysis.



The Alberta Research Council also continued chemistry projects related to agriculture. During 1982, scientists conducted tests on the application of chemical agents to control the loss of nitrogen fertilizers by microbial action in the soil. They measured the rates of nitrogen transformation, uptake and loss, and contributed data to validate a computer model for barley production that the University of Alberta is developing. This model will suggest changes in barley culture to achieve the most efficient production.

Biotechnology

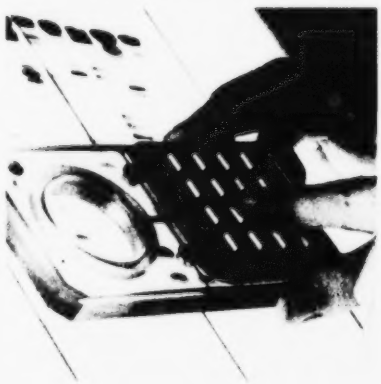
The province's agricultural productivity could be even greater if scientists at the Alberta Research Council are successful with research projects on the growth of plants at low temperatures. The basic goal of these projects is to extend the growing season of cereal crops in existing crop-growing regions and to introduce new varieties of crops that will grow in northern regions of the province where frost-free days are few. With newly developing technologies, such as plant-cell culture and recombinant DNA, scientists took a major step in developing the methodologies necessary to achieve this goal.

One project involved changing single embryo cultures of immature seeds to produce many plants instead of just one. The genetically desirable characteristics can be selected from a wide range of offspring, yielding more productive crop plants.

A second project concerned low-temperature growth of plants. A bacterium is encased in an envelope composed of proteins, carbohydrates and lipids (fats). Lipids adjust the fluidity of the envelope to an optimal level at a given temperature so that enzymes inside the envelope can function. If the lipids are 'thinner' than those that occur naturally, they can function at lower temperatures, much the way a thinner oil would be used to lubricate an engine during cold weather. Scientists are trying to develop those thinner lipids.

They have investigated a bacterium that has an unusual composition of lipids in its membrane that allows it to grow actively in a refrigerator. At room temperature, however, the bacterium seems unable to modify the lipid composition of its membrane to adapt it to room temperature, and dies. Scientists will continue to investigate specific components of lipids in the bacterium's membranes that allow low temperature growth. They will try to insert similar genetically derived lipid components into alfalfa or wheat to see if the plant's low-temperature growth can be improved. The problem is not a simple one and immediate solutions should not be expected.

In September, the Alberta Research Council/BIO LOGICALS inc. joint venture took up residence in the Alberta Research Council Campus Building. A meeting of the Scientific Advisory Board for the joint venture led to adoption of a plan to construct plasmids for the cloning and gene expression of synthetic genes of both natural and modified DNA sequences. Some areas of the project are expected to interface with work already underway at the Research Council. The VAX 11/780 computer at the Research Council will be used for the analysis of DNA sequences and chemically synthesized DNA will be supplied by BIO LOGICALS in Ottawa.



ABOVE: The study of plant growth at low temperatures is one contribution biotechnology can make to extending the growing season of crops and to introducing new varieties of crops in colder regions.

TOP RIGHT: Ligation of DNA performed in Eppendorf Tubes is the core of recombinant DNA technology.

RIGHT: The use of computer, gene synthesizer and other sophisticated equipment has added great speed to research into industrial applications of biotechnology, such as in the joint research venture with BIO LOGICALS inc.

Oil Sands Research

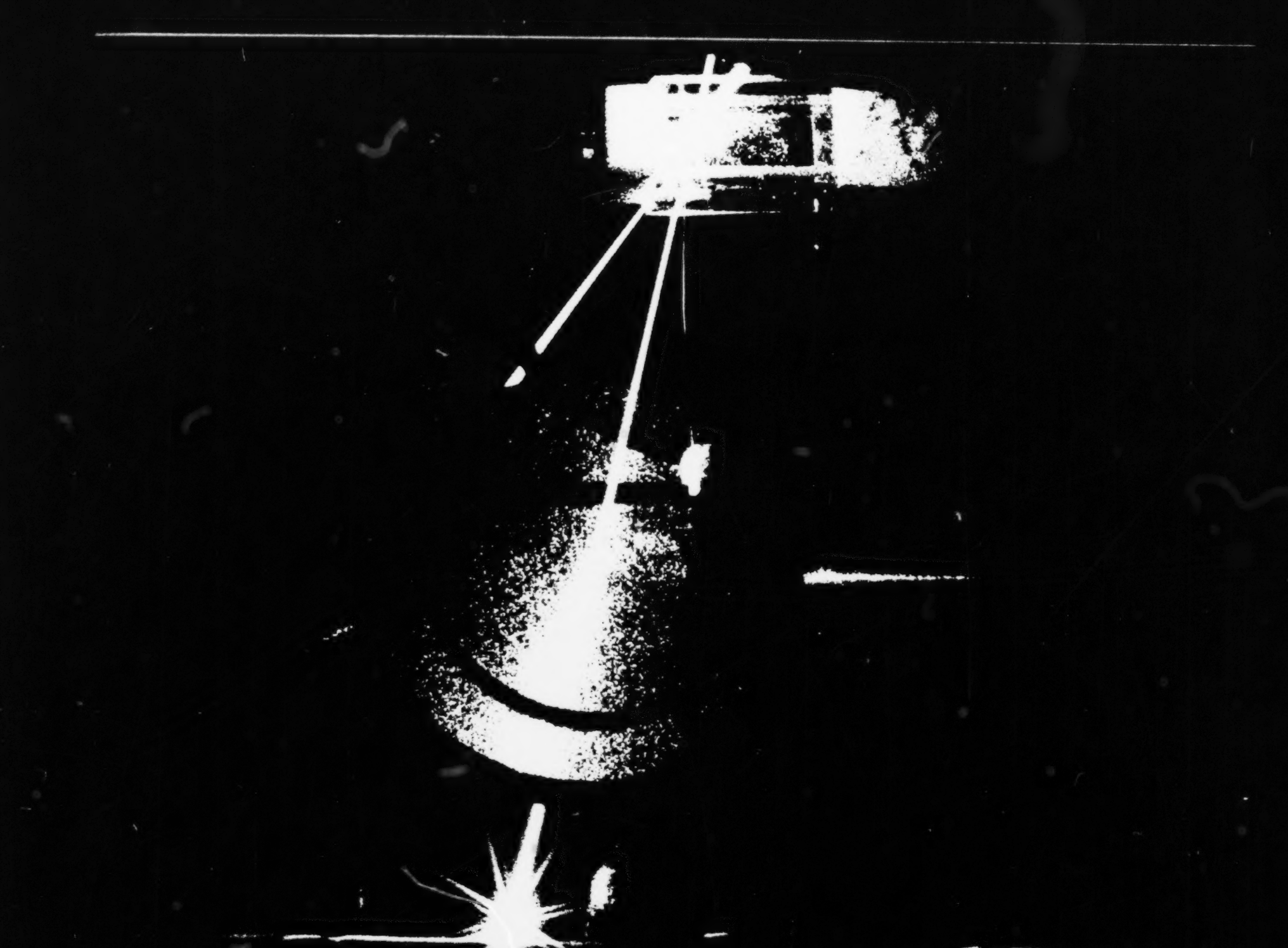
The Alberta oil sands deposits are among the largest hydrocarbon deposits in the world and must play a major role in Canada's future energy production. Two commercial enterprises Suncor Inc. and Syncrude Canada Ltd. — are using very large scale mining technology to extract the viscous bitumen from oil sands deposits near the surface for refining into fuel. Although the technology for these surface mining techniques is now well developed, surface deposits represent only 10 percent of the total estimated reserves. The Alberta Research Council's program is focused on developing a new technology, so that bitumen can be recovered directly from the 90 percent of the oil sand reserves lying up to 800 metres underground.

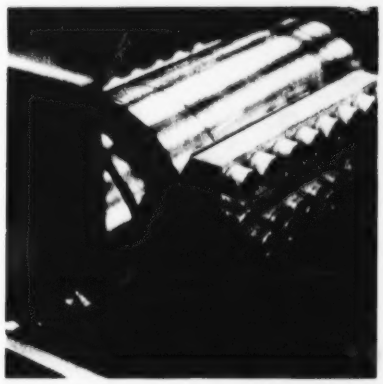
The basic problem is to develop a technology for separating the bitumen from the sand deep underground and move it to the surface. At low underground temperatures the bitumen is so viscous that it acts more like a solid than a liquid, so it must be heated or mixed with solvents to fluidize chemically, to allow it to flow through the pore spaces between the sand grains. Unlike conventional oil deposits, where there is usually sufficient pressure to move oil through the deposit to the recovery well, oil sands deposits have very little fluid pressure, so to move the viscosity-reduced fluids must be injected into the deposit to force the bitumen to flow. Finally, the hot fluids injected into the deposits can react with the rock to hinder or assist the movement of the bitumen.

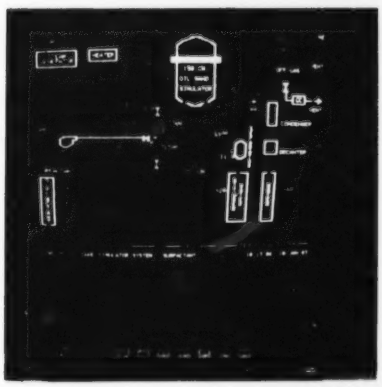
In keeping with its commitment of moving research to the commercial state, the Alberta Research Council has established with the Alberta Oil Sands Technology and Research Authority (AOSTRA) a program directing industrial access to an annual subscription basis to the range of the Research Council's joint research projects.

The problem geologists face is that with information only from borehole cores and logs they must try to predict in three-dimensional terms the geometry of zones of richer bitumen in relation to adjacent zones with sands poor in oil or bitumen content. In ancient beach deposits, for example, the oil sands have more homogenous particle and lateral continuity than do sands deposited in river channels. Once this is understood, the insight allows for the development of exploration processes sensitive to subsurface geological conditions.

Researchers designed and built this novel laser Doppler apparatus to use in measuring the surface properties of bitumen suspensions with more precision and speed than possible before.







TOP: This holder for oil sand core experiments in which the bitumen is displaced by steam has special windows to allow x-rays to measure how much steam and water are in the core at any time.

BOTTOM: Flow diagram of a test system is used to perform oil recovery experiments under simulated field conditions using steam, gas and solvent injection.

Advances in oil sands geology research during 1982 included the determination that the Grand Rapids Formation of the Wabasca Oil Sands Deposit represents offshore and coastal plain sedimentation. Alberta Research Council geologists also developed an estuarine-tidal flat model for deposition of sediments in the Peace River Deposit. They deciphered in detail the form and configuration of the deep channels in the Athabasca Deposit. Finally, they determined that the heavy oil belt of the Suffield region in southern Alberta contains beach and associated deposits. The results of these studies indicate that the geology of these various reservoirs is so diverse that any one in situ extraction process is unlikely to be effective in more than one or two deposit regions.

In 1982, the Alberta Research Council also completed a three-year project to develop a mathematical model to describe the process of in situ extraction for interpreting and predicting the effectiveness of various bitumen extraction processes based on the injection of steam with added solvents and gases. Scientists also performed a wide range of experiments under simulated field conditions, using steam and the additives, carbon dioxide, flue gas and surfactants, further dramatically demonstrating that additives to the basic steam recovery process can improve significantly the rate and volume of bitumen removal. Furthermore, they found a way to prevent the additives from degrading at the high temperatures of the steam, so losing some of their effectiveness. Before 1982, investigations into recovery techniques were primarily related to the Athabasca Oil Sands Deposit, but the rock formations in the areas of the province's other oil sands deposits vary widely and during 1982, the Alberta Research Council developed procedures and equipment to study the Cold Lake Deposit.

Laboratory programs are proceeding quickly in several new directions. X-ray methods are under development that will measure fluid saturation profiles inside the high pressure, high temperature equipment that must be used to study displacement under process conditions — a long-standing problem in the industry. A laboratory for the study of thermodynamics of high temperature solutions has been established to obtain data for modelling the chemical reactions between additives, minerals and the gases released from bitumen under reservoir conditions.

The surface properties of bitumen largely determine the ease with which it is removed from the formation and, later, its recoverability from the water bitumen mixture that is produced. Researchers studying surface and interfacial chemistry have successfully designed and built a novel laser Doppler velocity meter, which will be used to measure the surface properties of bitumen suspensions with much more precision and speed than possible with existing methods. Scientists also used the Alberta Research Council's newly developed physico-chemical model for oil sands structure to quantify the effect of pH and

calcium ions on the hot water bitumen extraction process. Laboratory experiments provided additional evidence for the applicability of this new model.

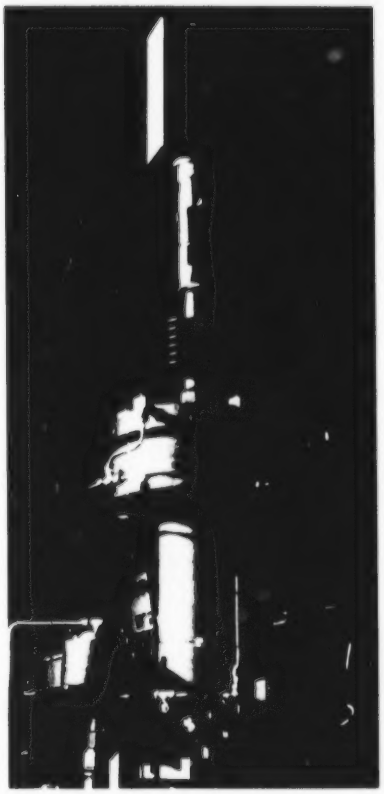
The Alberta Research Council also took further steps towards the mathematical simulation of bitumen extraction. Researchers are applying fundamental principles of physics and advanced theoretical methods to predict relative permeability and characteristic curves for capillary pressure and saturation in the water-oil-sand system.

Other developments in 1982 included the start of new experiments on the physical characteristics of oil sands. For the first time, scientists measured the resistance of the sand to the flow of fluids over a range of high temperatures and pressures. Equipment to measure the viscosity of bitumen at high pressures and temperatures also produced specific results. These results are being incorporated into the mathematical model mentioned above, which is designed to assess the effectiveness of different recovery schemes.

The Alberta Research Council completed development of a new coking process for bitumen upgrading. Adding a small amount of $Ca(OH)_2$, or lime, to the bitumen prior to coking, can increase the yield of liquid product. The new process also can bind a large proportion of sulfur into the coke produced, as gypsum, effectively removing it and allowing the coke to be burned as a fuel without harm to the environment.

Using previously developed models, the Alberta Research Council also did technical and economic analyses. Scientists studied the impact on the Canadian economy of different natural gas export levels in order to establish a basic scenario for development of Alberta's energy resources. The Alberta Research Council models used in the study were an Alberta Energy Resources Allocation Model (AERAM) and a Canadian Energy Economy Model (CEEM).

In its fifth year of operation in 1982, the Oil Sands Sample Bank increased its volume of shipments by 26 percent over the previous year. It shipped 150 tonnes of oil sand samples to various petroleum research laboratories in the world.

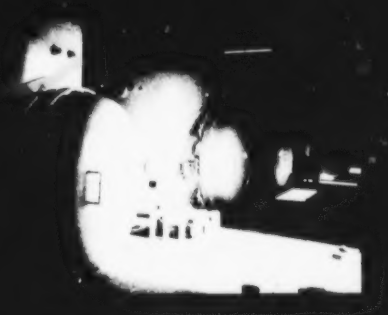


This new high pressure viscometer is unique in that it is capable of working at subsaturation gas concentrations and will measure the viscosity of unstable oil-in-water emulsions.

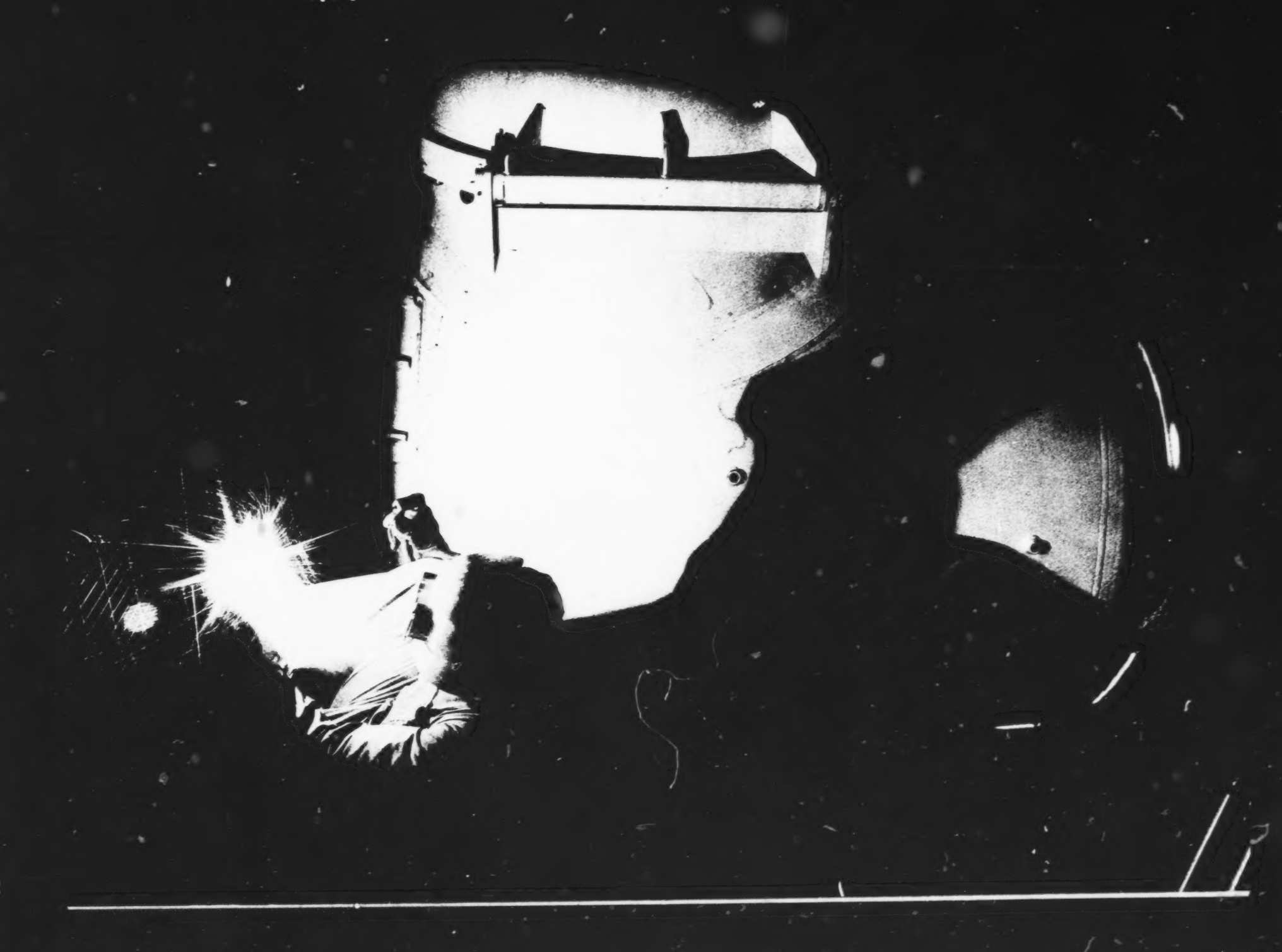
Coal Research

Alberta has about 80 percent of Canada's known coal reserves which amount to at least as much energy content as all known reserves of oil sands and heavy oil in the province. The extent, quality and availability of coal reserves underneath the Alberta Plains makes coal a potential source of liquid fuel to meet the energy demands of future years. Coal can be converted to many products such as fuel gas and synthesis gas for hydrogen and ammonia production but liquid fuels remain the most attractive because they can be transported cheaply over long distances. The high energy density of liquid fuels also makes them uniquely suitable as fuels for transportation and agriculture. Furthermore projected long-term increases in oil prices, Canada's desire to become self-sufficient in energy and efficient coal conversion technology of the kind the Alberta Research Council is investigating could make coal economically competitive as a future source of synthetic fluids.

A lot of information about European, Eastern American, Japanese and Australian coals is already available. Western Canadian coals, however, are different in physical and chemical structure and geological origin. Since coal conversion processes depend on the characteristics of the feed coals, the Alberta Research Council is investigating coal conversion technologies to suit local coal characteristics and production capabilities, as well as the geological characteristics of the coal deposits themselves.



Containment cells at Nisku are among the safety features installed for research work. Coal researchers are currently testing several Alberta Plains coals under different processes to find the most suitable one in each case for conversion and partial conversion to liquids.



TOP: Coal from the Battle River area gave the highest average conversion ratings among the three reference coals tested in five different processes.

BOTTOM: Under a technology exchange agreement between Canada and Japan, the Alberta Research Council has participated in exchange of information on coal conversion technology with the Japan Agency for Industrial Science and Technology (AIST), in association with their New Energy Development Organization (NEDO).

In the coal geology project, funded jointly by Alberta Energy and Natural Resources and the Alberta Research Council, the stratigraphy and facies relationships in the Bearpaw-Horseshoe Canyon sequence of the Drumheller area were worked out in detail. Significant progress was also made on similar studies of the Belly River Formation coal measures of Dinosaur Provincial Park and the Paskapoo Formation sequence of the Red Deer area. The Scollard/Paskapoo study was complemented by a drill program in the immediate vicinity of the Red Deer valley exposures.

In a separate project initiative, a study was completed on the variation in rank of the shallow Plains coals, based on stratigraphic and statistical analysis of more than 600 coal samples. It is evident that coal rank varies systematically from subbituminous C to high volatile bituminous C. The increase in coal rank towards the Rocky Mountains was found to be related to greater original overburden thickness in that direction, as opposed to the traditional view that this coal was formed under pressures exerted during formation of the mountains.

Liquefaction, a process by which coal is converted to synthetic oil, is one of the Alberta Research Council's major areas of research. During the year, research staff took a major step towards identifying how coals from different regions of Alberta might be affected by different liquefaction conditions. They have evaluated three reference coals under conditions of high pressure and temperature that are representative of five different process types being developed in West Germany, the United States and Japan.

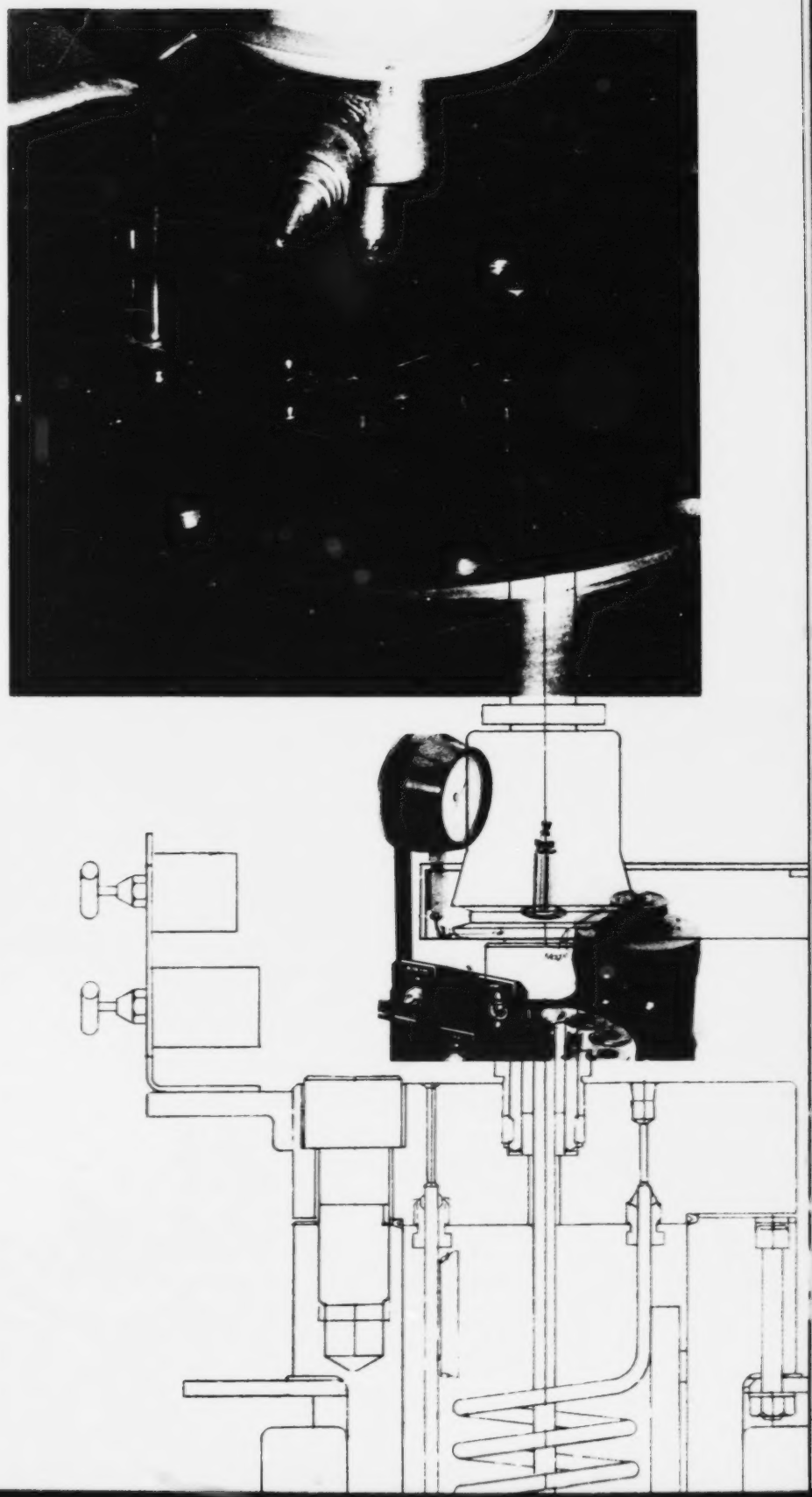
The major features of each process investigated in these autoclave tests were: type and concentration of conversion catalyst; coal-derived solvents; bitumen and bitumen-derived solvents; reactant gases consisting of hydrogen, carbon monoxide and steam mixtures; heating rate; reaction time and temperature. Researchers have been able to make reliable comparison of coal types on the basis of their reactivity and liquid yields, hydrogen consumption and composition of coal solids remaining after the conversion process.

Of the three reference coals tested in the five processes, the coal from Battle River gave the highest average conversion ratings of 95 percent to liquid and gas products. Coal from Smoky Tower had the next highest conversion rate; Wabamun coal had the lowest conversion, although one process achieved up to 90 percent conversion.

Now that the Alberta Research Council has completed this preliminary autoclave work with the three reference coals, it can establish standard procedures for rapidly and accurately comparing evaluations of small coal samples under various process conditions. For instance, coal samples identical to those tested in-house have been tested with other processes at research centers in other countries.

Research staff are working on experiments to provide some criteria and correlations to predict or explain the liquefaction behavior of Alberta coals. The autoclave program continues with evaluation of three coals from fields with commercial potential: Fox Creek; South Swan Hills; and Red Deer (north and south parts).

Pyrolysis, or partial liquefaction, is a process in which some valuable liquid fuels and chemicals are separated from the coal before the residue or char is burned. Researchers are evaluating Alberta coals in various processes to determine the amount and quality of oil produced and the suitability of the char as a feed material for thermal electric plants. Coal from the Wabamun Field Highvale mine was tested at reaction temperatures from 550 to 800°C and 0.4 seconds residence time. The maximum oil yield was obtained at temperatures between 650 and 700°C. Coal from other regions will be tested to determine process conditions that produce the largest amounts of liquid products. The combustion reactivity of char produced is also an important factor in selecting the best pyrolysis conditions for particular coals.



An autoclave produces the high pressure and high temperature for rating different coals on their suitability for conversion to liquids.

Natural Resources Research

Air

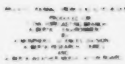
Hailfall damages over $100 million in farm crops every year in Alberta. Mainly for this reason the Alberta Research Council is operating a five-year project sponsored by Alberta Agriculture and the Alberta Research Council, to assess the feasibility of weather modification. This was the second year of the project conducted in an experimental region within a 150 km radius of Red Deer. Cloud seeding operations for hail suppression were conducted from late June to the end of August, but in the area between Red Deer and Calgary only. The northern half of the experimental region, between Red Deer and Edmonton, was devoted this year to specific cloud seeding experiments. Those experiments became possible with the inauguration of a new, sophisticated research aircraft for making measurements in storms, which represented a major breakthrough in technical capability.

The new research aircraft, a Cessna 441 Conquest, is leased for the hail suppression research from INTERA Environmental Consultants Ltd. of Calgary. The Alberta Research Council developed jointly with INTERA the computerized weather data system on board the aircraft to enable readings at high aircraft speeds within storm clouds. During the summer hail season the aircraft flies 112 hours of research missions. Scientists collected data with the aircraft during the experimental seeding of three major storms in 1982. The data were analyzed over the fall and winter months.

TOP: A data processing system developed by the Alberta Research Council in conjunction with Scientific Engineering Associates (a U.S. based firm) and INTERA Environmental Consultants Ltd. (a Calgary based firm), allows measurements to be taken at high aircraft speeds inside storm clouds.

BOTTOM: Sophisticated measurement devices using laser technology are linked to the computer system inside the aircraft and measure the size of water droplets and ice crystals.

RIGHT: During the summer hailfall season, researchers in Red Deer track storms with weather radar and direct cloud seeding aircraft. Knowledge is constantly improving in this huge experiment on effective methods of weather modification.



TOP: Spinoff technology from weather modification research supports a flood forecasting system.

BOTTOM: The data processing system linked to the weather radar can generate this map of rainfall, helping to provide warnings of heavy runoff in areas prone to flooding.

Floods and droughts are also a major problem in Alberta, causing tens of millions of dollars damage to farm crops and other property every year. The Alberta Research Council's weather modification project was expanded to include research into the prospect of suppression and enhancement of rainfall where required and into snow augmentation.

Based on experiments of three and four years ago, scientists concluded that rain could sometimes be initiated by seeding clouds that would not produce rain naturally. In the summer of 1982, scientists seeded eight clouds to produce rain. Of the eight clouds seeded, three produced a radar echo indicative of rain that had fallen to the ground. Scientists are now analyzing aircraft and radar data to determine if the rain was initiated by the cloud seeding.

The Air subprogram diversified its research in 1982 with a project to investigate the effects of sulfur emissions in Alberta on precipitation processes. It also carried out contract work for the Canadian Atmospheric Environment Service to support their RAINSAT project, designed to improve short-term weather forecasting by analyzing radar and satellite data. Contract work continued for Alberta Environment to provide the River Forecast Center with a system of real-time rainfall information from weather radar, by 1984. The Alberta Research Council also became involved in a consulting subcontract to define the meteorological requirements of the next generation of weather radar for the United States government, which has asked two companies to define a radar system and provide a bid for supplying the system.

A study to determine the efficiency of seeding clouds with ground-based generators was conducted in southern Alberta.

Land

As Alberta companies continue to mine the huge reserves of coal in the Plains Region, the Alberta Research Council is developing a framework for predicting the impact of the mining on local and regional water resources and the probability of long-term success in land reclamation. In 1982, most of the work was on mining properties in the Forestburg area.

Scientists found that groundwater in mine spoil is two to five times more saline than water in unmined aquifers. In some cases, the groundwater in mine spoil was flowing into adjacent, unmined aquifers. Analysis of spring discharge, however, indicated that the potential for deterioration of water supply in the Battle River by seepage of groundwater from mine spoil was small. Water table position in mine spoil and the rate of groundwater recharge appear to be strongly influenced by the presence or absence of ponds on the reclaimed landscape. Where ponds are absent, spoil resaturation is slow and, conversely, where ponds are present, recharge is more rapid.

The information and concepts being developed in this project will be very useful to private industry in the design of post-mining landscapes and to the government in the design and implementation of more effective regulations.

There is a large demand in Alberta by private industry, government and individual citizens, for high quality soils information. At the request of Alberta Municipal Affairs, a project was initiated in 1978 to map the soils of Beaver County and to interpret the soil units for agricultural capability. The Alberta Research Council completed mapping of the 37 townships in 1982. During this five-year period, a soil climate program has been conducted in the county. Furthermore, scientists have assessed naturally occurring levels of trace elements in the surface layers of the county's major soil types. The information from this project will be valuable to Alberta Municipal Affairs in making specific land-use decisions and for designing a regional plan of the county. It will also provide a basis for tax assessment and for the sale of agricultural land. Alberta Agriculture will be able to use the information to identify problem soils that require research work, and to estimate the potential productivity of soils under different land management methods. Alberta Environment will be able to use this information to predict more effectively the impact of resource development within the county.

Scientists at the Alberta Research Council have also been studying the geology and soils of the Calgary region. Observations from several thousand natural and artificial exposures combined with about 300 drill holes completed by project personnel and an examination of data from 3000 existing testholes have been synthesized into four surficial geology maps at a scale of 1:50,000 which are scheduled for release in early 1983. A significant finding of the study has been the discovery of an extensive bed of buried gravel, nearly continuous from Nose Hill to at least as far west as Cochrane, with an overburden cover commonly less than 10 metres thick. The Alberta Research Council also completed a five-year soil survey of the Calgary urban perimeter. This information will help in the planning and development of the Calgary area.

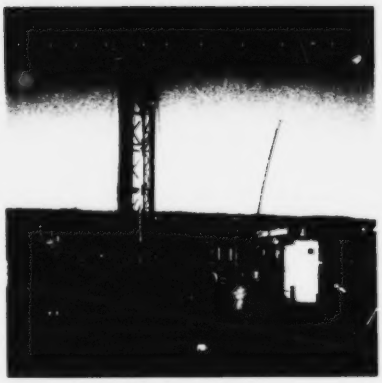
Additional land resource studies include investigations of the Quaternary geology of various parts of the province including a large portion of southern Alberta, the Medicine Hat-Lethbridge region, the Edmonton region, and smaller portions of east-central Alberta. A major soil survey of Paintearth County is underway in conjunction with Alberta Agriculture to identify those soils that will potentially provide greater crop yields with deep ploughing. Also, a preliminary study of the peat resources of the province has been initiated.

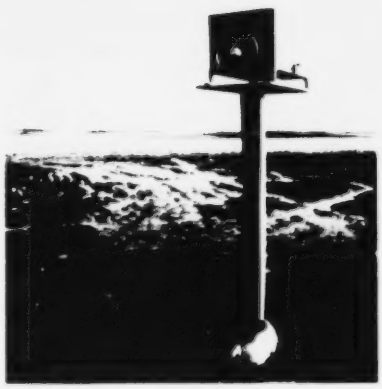
The general objective of all of these studies is to provide information about Alberta's land resources to those involved in their management so that the potential of this important resource can be optimized.

Water

While the goal of the Alberta Research Council's Oil Sands Research program is to develop the most effective in situ oil sands extraction processes for the lowest possible cost, evaluating the potential environmental impact of these in situ processes is the pursuit of a major project in the Water subprogram.

In April, the Alberta Research Council and Alberta Environment started a joint project in the Cold Lake area where in situ oil sands





TOP: Drilling core samples have helped researchers produce surficial geology maps of regions in Alberta.

MIDDLE: Land reclamation studies provide information to assist private industry in improving the design and productivity of post-mining landscapes.

BOTTOM: Monitoring instruments in the Pine Lake basin help determine relationships between surface and subsurface waters and provide information for use in water resources management.

extraction projects are planned. The study will evaluate the effect of in situ oil sands recovery on the presence and quality of local and regional groundwater resources. It also will provide information to aid objective decisions for disposal of fluid wastes from the extraction processes into deep, permeable geological formations. Finally, the project will provide industry with a regional framework of the hydrogeology of the Cold Lake region within which the results of detailed research on experimental sites or company leases in northeastern Alberta can be evaluated. During the first nine months of the project, scientists assessed information for defining the geologic framework, the distribution of aquifers and aquitards (less permeable strata than aquifers) and groundwater chemical types.

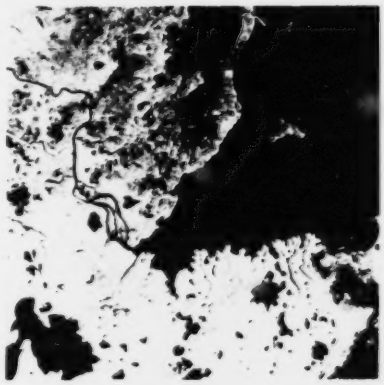
Staff in the Water subprogram also completed theoretical studies on well and aquifer hydraulics. The results of these studies now provide scientists with improved methods for analyzing aquifer tests in fractured formations and for reliable interpretations of factors causing well losses.

Another project related to oil sands extraction was a cooperative study with the Alsands consortium. The study was to determine the effect of removing water from a large, open pit in the Athabasca oil sands area: would saline groundwater from the deep, Methy aquifer move upward and contaminate the shallow aquifer at the base of the oil sands as well as local surface water bodies? The relative contents of the rare isotopes deuterium and oxygen-18 in waters from the Methy and Basal oil sands aquifers were very different. When the chemistry and pressure within the aquifers were considered as well, the conclusion was reached that the Methy and Basal aquifers are not hydraulically connected within the time frame of an oil sands mining project, roughly estimated to last for about 30 years. In the context of geological time, however, a hydraulic connection was not ruled out.

Another conclusion of the cooperative study was that sulfate in groundwater from the Basal and Methy aquifers is likely derived from sea water sulfate originally buried in the sediments, that has been relatively unaffected by bacterial sulfate reduction. This information is helpful because it demonstrates that little flushing of salts from the aquifer has occurred. A third conclusion is that groundwater in the Basal aquifer is recharged through the oil sands within a five- to ten-year period. This information indicates that the oil sands are more permeable to water than previously believed.

To determine the ultimate maximum amount of water available for exploitation in a given area of the province, the annual amount of water recharging the local groundwater reservoir must be known. Currently water management is based largely on estimated amounts. The Alberta Research Council is gathering data in a field experiment to determine whether knowledge of the actual data, rather than estimates, will prove significantly more effective in wise water management. For this project, scientists have installed monitoring instruments in the Pine Lake basin southeast of Red Deer. Interpretation of the data will begin early next year.

The Lake Athabasca delta is an ecologically sensitive area which is important for wildlife breeding. The flow of water in the delta is complex and varies by season of the year. The Alberta Research Council is developing a mathematical model of the flow patterns in the delta area and is using satellite imagery to assess circulation patterns and water quality variations in Lake Athabasca. The results will improve the capability of assessing environmental impacts which may occur because of industrial activity upstream of the delta.



The objective of an Alberta Research Council project is to develop a mathematical model of flow patterns in the Athabasca River Delta. This will assist in understanding the environmental impact of upstream industrial activities.

Earth Resources

The rock and mineral resources form an important base to Alberta's economic development. Knowledge of these resources is vital.

In an Aggregate Inventory Project, research is designed to synthesize existing data on sand and gravel resources and identify, map, sample, and test previously unknown deposits. In 1982, the Alberta Research Council continued work in the more populated regions of the province, mainly in central Alberta.

A supply and demand study on sand and gravel resources in the Edmonton-Lloydminster corridor began in 1982, so information from the study can be related to economic and market conditions, projected population and municipal growth, and other natural resource developments.

The Aggregate Inventory Project operates under a contract with Alberta Energy and Natural Resources, and the contract was renewed for five years.

Agriculture in Alberta depends heavily on chemical fertilizers, and phosphate, an important component in fertilizer, currently is imported from abroad. The Alberta Research Council has completed an assessment of the province's potential phosphate-bearing strata, identifying four distinct formations with significant potential. With this information, Alberta can make its long-range plans for phosphate requirements.

Other province-wide commodity surveys that were completed include the appraisal of Alberta's clays and shales as industrial raw materials, and the survey of salt and gypsum resources.

In the Precambrian Shield Project, the last geological map was completed in draft form, a study of Shield metamorphism was published, and a parallel report on the history of deformation in the area was prepared. Similar synthesis research is now underway on the geochemistry and geophysics of the Shield.

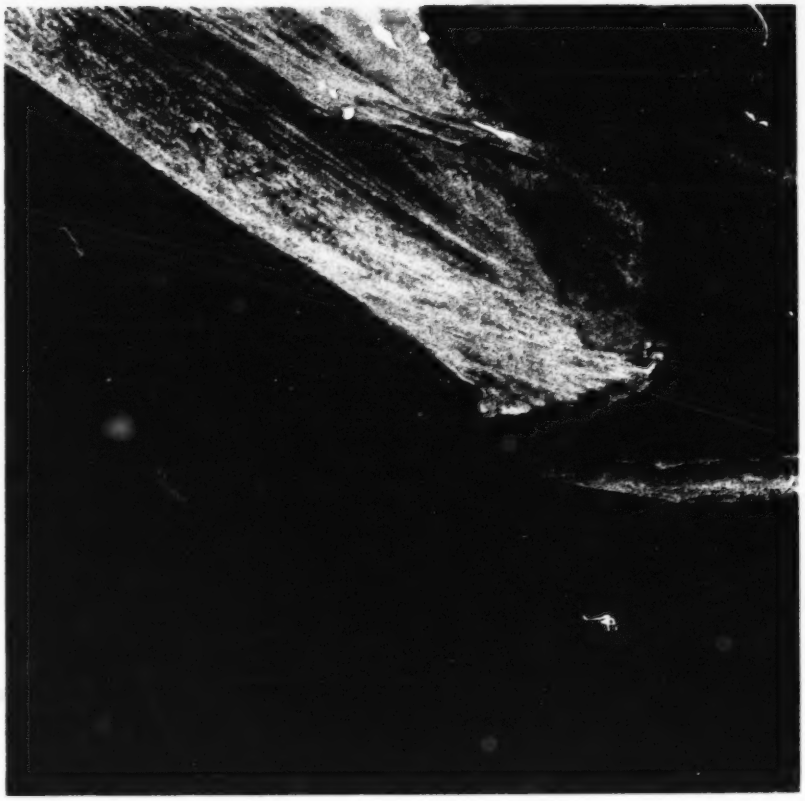
The enormous natural gas reservoirs of the Deep Basin in northwestern Alberta are under geological investigation. The research shows that geological processes have altered the sandstone reservoirs so that leakage of gas is extremely slow. The sandstone, therefore, is diagnosed as being its own trap, independent of other geological considerations that normally act to confine a reservoir. This mechanism of hydrocarbon trapping, previously unconsidered, accounts for many unusual features about this kind of accumulation, possibly providing a key to more efficient methods of tapping gas reservoirs.

Research on the uranium-bearing Athabasca Basin of northeastern Alberta was focused in 1982 on the stratigraphic and petrologic characterization of the sandstone sequence.

Detailed structural analysis of foothills coal measures was continued during 1982 with the completion of field work in the Grande Cache area.

Specialist studies in palynology and ichnology achieved significant advancement during 1982, both in terms of basic research and in collaboration with researchers in coal, oil sands, and petroleum geology. An Alberta Research Council bulletin on the Cenomanian microflora of the Peace River country was completed in 1982 for publication in 1983. Fundamental ichnological research was concentrated on the trace fossil assemblages in the Cardium Formation of southwestern Alberta and on the Chungo Member of the Wapiabi Formation near Canmore.

Evaluation and surveys of Alberta's mineral resources on land and, in this case, by helicopter, are continuing activities of the Alberta Geological Survey.



Information and Support Services

The Alberta Research Council operates six information centers that provide information for people in industry and government, to the general public, and that also are used by staff members. It also supports its research programs with a variety of services: technical laboratories, a computing network, machine shops, instrumentation repair, drafting, human resources, safety, financial services, editing and publication sales.

Alberta Oil Sands Information Center

The Alberta Oil Sands Information Center was established in 1975 through a grant from the Alberta Oil Sands Technology and Research Authority (AOSTRA). The center, which is managed by the Alberta Research Council, continued to operate as a central source of all published information on oil sands and expanded its service to include enhanced recovery processes and heavy oils. It responded to approximately 3000 enquiries.

The bibliographic databases were made available online on QL Systems, based in Ottawa, to add to access already available through SPIRES at the University of Alberta.

The center completed a numerical database on international information about physical properties of oil sands, in conjunction with the Alberta Research Council's Oil Sands Sample Bank. Another online database, the Oil Sands Researchers and Projects File, was expanded to include those working in the heavy oil and enhanced recovery fields. A bi-monthly newsletter, the TAR Paper, was distributed to over 1200 subscribers in 28 countries.

Coal Technology Information Center

The Coal Technology Information Center is part of the Alberta Energy and Natural Resources and Alberta Research Council Coal Conversion Research Program, jointly funded by both organizations. The center provided information on mining technology, coal beneficiation, coal conversion, combustion, environmental aspects and energy policy.

During 1982, the center responded to more than 3000 enquiries for an increase of 88 percent over 1981. Also, the computer information system, Coal-Abs, which is available on-line through SPIRES at the University of Alberta, increased by 2500 entries to a total of 10,000. Two publications were produced by the center for subscribers: the *Current Acquisitions Bulletin,* a semi-monthly update of new material added to the database; the *Coal-Abs Index,* a cumulative list of holdings in the database.

GEODIAL

The information center for the Alberta Geological Survey is known as GEODIAL. Over 5000 records of geological literature are now on file in the GEODIAL database and commercial usage of the service is increasing. The newly established position of Information Geologist became fully functional during 1982, with the result that external requests for information relating to all Geological Survey activities are now handled on a much more efficient basis.

Information Systems Group

Information Systems is the information center that interacted mainly with manufacturers, as part of the Industrial Development subprogram. Clients in Alberta had access, through offices in Calgary and Edmonton, to 95 percent of the world's published scientific and technical literature in the more than 500 databases of 10 computer systems in Canada and the United States. This service was provided to people representing industry and government in over 400 enquiries which resulted in 1500 individual bibliographic searches.

SWERP Information Center

The SWERP (Solar and Wind Energy Research Program) Information Center, established in 1977 and funded by the Alberta/Canada Energy Resources Research Fund (A/CERRF), collected and disseminated information on solar and wind energy. Information requests from the general public, governments, industry and commercial sectors, educational institutions and other libraries or information centers amounted to approximately 2000 during 1982. The center continued to assist the National Research Council in developing a Canadian renewable energy database. It also expanded its database on Alberta manufacturers and suppliers related to solar and wind energy.

Library

A strong information support system is essential to the Alberta Research Council's effectiveness as a research center. Library Services provided that support through its branches at Terrace Plaza, the Campus Building and Clover Bar with its collection of 50,000 books and government documents. It responded to about 75,000 requests from staff, 7000 requests from the Alberta Research Council information centers and 3500 external requests for a total increase of 6 percent over last year. The library has access to the SCITECH data base, a joint library management project with Alberta Agriculture and Alberta Environment to provide access to computerized bibliographies of international scientific and technical literature. It continued the cataloguing component of SCITECH. A computerized database, SERIALS, which provides easy access to the collection of 600 journals, was upgraded.

Analytical Services

The Chemistry Analytical Laboratory supported projects in all five research programs, providing qualitative and quantitative analysis of organic and inorganic substances. It also did analyses for private industry and government departments and agencies such as Alberta Energy and Natural Resources, Alberta Farmer's Advocate, Alberta Occupational Health and Safety, Environment Canada, and the Royal Canadian Mounted Police.

The Coal Analytical Laboratory provided analyses of coal and coal-derived products in support of the two major coal conversion projects, liquefaction and pyrolysis. The laboratory's services expanded during the year by introducing thermogravimetric analysis methods, developing quantitative, thin-layer chromatography, simulated distillation and gas chromatography-mass spectrometric methods.

The Gasoline and Oil Testing Laboratory assisted government departments and industry with a wide range of testing and inspection services to solve problems related to transportation fuels and lubricants. It coordinated a sample exchange program across Canada among petroleum refining laboratories. This program helps maintain high laboratory standards and accurate test methods. It also published an annual survey of the quality of motor gasolines sold in Alberta.

The Oil Sands Analytical Laboratory supported projects in the Oil Sands Research Program, and other research programs with specialized services. It also provided an advisory service for industry and commercial laboratories and conducted special analyses not available from commercial laboratories. Approximately 20,000 analyses were conducted during the year. One major project the laboratory supported was the measurement of viscosity at elevated pressures of bitumen with some dissolved solvents. As part of its effort to improve analytical methods and develop new ones, the laboratory also studied the interferences related to analysis of metals in bitumen.

The Sedimentation Analytical Laboratory provided support for geologists, including preparation of 900 thin-sections of rock and of sediment samples, 100 size analyses of sand, silt and clay and over 1000 other sample preparations. These were in support of oil sands geology studies, uranium geology studies in the Lake Athabasca area, and phosphate studies in the Foothills.

The Alberta Soil Survey Analytical Laboratory is operated jointly by the Alberta Research Council and Agriculture Canada to provide routine analysis for soil survey and research projects. The laboratory provided 9500 analyses on 960 soil samples in support of soil studies during the year.

Computing Services

Specialized computer systems support many of the research programs. To achieve the efficiency of sharing hardware, software and personnel, the Alberta Research Council has established a 15-node, in-house computer communications network.

A sophisticated computer software program for analysis was developed to allow researchers control of data acquisition for a variety of analytical instruments, to apply a library of analytical and statistical tests and to write reports on a variety of output devices. Industrial analytical laboratories across Canada have expressed interest in this program known as RLS (Real-time Laboratory System). The Alberta Research Council also conducted a joint project with Alberta Government Telephones to test the viability of long-distance laser point-to-point intercomputer communications devices in northern climates.

Machine Shop

The Machine Shop is an essential facility at the Alberta Research Council for building research apparatus to researchers' specifications. During 1982, the Machine Shop was devoted largely to the installation of containment vessels for coal research facilities in Nisku and the construction and installation of additional apparatus. It also continued to provide services for oil sands research, provided maintenance service on the weather radars in Red Deer and apparatus for chemistry and industrial and engineering research projects.

Instrument Repair

Instrument Repair maintains a major portion of the analytical and electronic equipment in the Alberta Research Council. In the past year it assisted in the installation of the in-house network of terminals and computers. Also it has assisted in the installation of the network connected with the Solar and Wind Energy Research Program. In June Instrument Repair moved to a new facility at Parson's Property, which provided more space, and facilities for making printed circuit boards for the great variety of research apparatus.

Drafting Services

Cartography is one of the main functions of Drafting Services, largely in support of the Natural Resources Research Program and of the geological aspects in the Oil Sands and Coal Research Programs. During 1982, Drafting Services completed 18 aggregate resource maps of Central Alberta, 8 oil sands geology maps of the Fort McMurray area, 4 soil maps of the Fox Creek area, 2 surficial geology maps of Calgary, a surficial geology map and a bedrock geology map of the Sand River area, and a hydrogeology map of the Peace River area. It also provided miscellaneous drafting services and photographic services for technical reports and presentations and for public relations projects. Mechanical drafting services are supplied to oil sands research at Clover Bar, and to coal research at Nisku.

Human Resources

The Human Resources Department played a leading role in the formulation and development of human resources policies, and assisted several line departments with defining and implementing manpower plans based on organizational restructuring. The department also supported the

recruitment activities of several departments by visiting university campuses across Canada to interview and counsel students regarding careers in research. As well as implementing in-house training programs on performance appraisal, technical report writing, and supervisory development, the department developed formal policies dealing with recruitment and selection, pay administration, performance appraisal, and occupational health. Expansion of personnel systems and procedures to support increased administrative reporting needs continued throughout the year. The pre-employment medical assessment program was fully implemented, and negotiations for a new collective agreement were carried out.

Financial Services

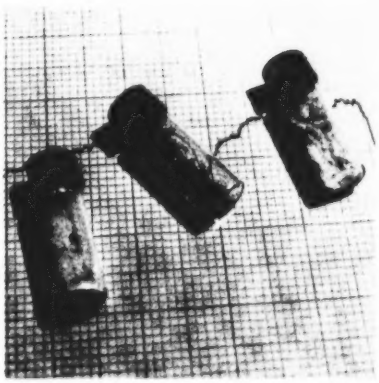
The Financial Services Department is responsible for planning, direction, coordination and control of the Alberta Research Council's financial assets and resources and the timely recording and reporting of all financial activity. In January 1982 a three-year financial development plan was approved by the Senior Management Committee and the Board of Directors. Implementation of this plan has begun and is highlighted by the start of a fixed asset accounting system, a complete inventory of all the Alberta Research Council's fixed assets, the acquisition of a VAX 11/750 Digital computer and the purchase of a packaged accounting system for project costing and reporting.

Safety

The Safety Office managed the volunteer services of 148 staff members to act as evacuation wardens or serve on safety committees and emergency squads. During 1982, training for the emergency squads included industrial firefighting courses at the Vermilion fireschool, the Alberta Disaster Services basic rescue course, and the Canadian Association of Oilwell Drilling Contractors' course in Hydrogen Sulfide Training.

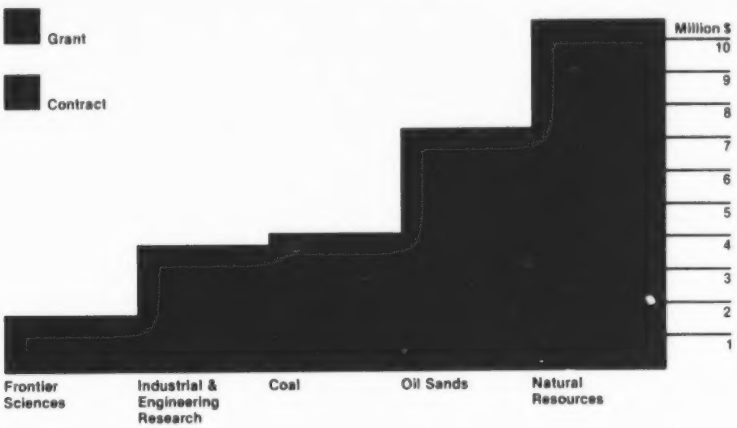
Editing and Publications

The Editing and Publications Department provided editorial services, typesetting, design, layout, printing, and distribution of the Alberta Research Council's technical reports and other publications. A new photo-typesetting unit enabled the department to double production over the previous year from 10 reports in 1981 to 19 reports in 1982. The department also began providing its services to the Coal Research and Oil Sands Research Departments. The distribution of publications was improved and was expanded through a new outlet in the Calgary office.

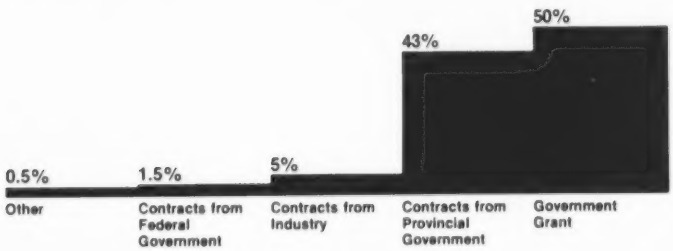


Analytical services provide essential support to all of the research programs.

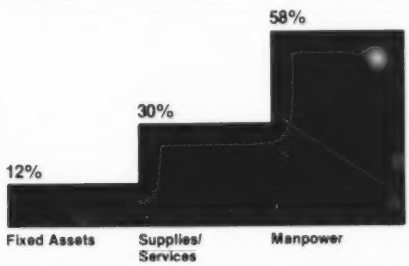
Program Breakdown of Expenditure by Source of Funds



Sources of Funds



Expenditures



Financial Statements

ALBERTA LEGISLATURE
OFFICE OF THE AUDITOR GENERAL

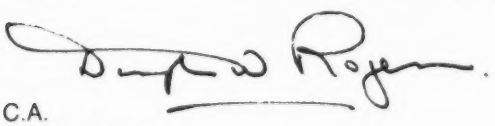
Auditor's Report

To the Board of Directors of
the Alberta Research Council

I have examined the balance sheet of the Alberta Research Council as at March 31, 1982 and the statements of revenue, expenditure and operating surplus and trust fund transactions for the year then ended. My examination was made in accordance with generally accepted auditing standards, and accordingly included such tests and other procedures as I considered necessary in the circumstances, except as explained in the following paragraph.

As disclosed in Note 4 to the financial statements, during the 1979-80 fiscal year the Council commenced to account for fixed assets previously acquired. However, since detailed cost records for these fixed assets were not available, the Council recorded them in the balance sheet mainly at estimated acquisition cost. In addition, the Council has entered into research contracts which specify that the Council does not receive title to fixed assets purchased until completion of the contract or at the discretion of the sponsor. Since detailed cost records for some fixed assets were not available and the Council did not identify those fixed assets to which it may not have title, I was unable to determine if any adjustment might be required to the balance sheet to adjust fixed assets and capital surplus to reflect actual acquisition cost and ownership of the assets.

In my opinion, except for the effect of adjustments, if any, which I might have determined to be necessary had I been able to examine documentation supporting the acquisition cost of fixed assets and also to identify assets to which the Council may not have title as described in the preceding paragraph, these financial statements present fairly the financial position of the Council as at March 31, 1982 and the results of its operations for the year then ended in accordance with the disclosed basis of accounting described in Note 2 to the financial statements applied on a basis consistent with that of the preceding year.



C.A.
Auditor General

Edmonton, Alberta
November 8, 1982

STATEMENT A

ALBERTA RESEARCH COUNCIL
BALANCE SHEET
AS AT MARCH 31, 1982

Assets

	1982	1981
Current:		
Cash	$ 6,000	$ 2,480
Deposits in trust (Note 3)	4,011,866	212,153
Accounts receivable	3,095,431	4,855,214
	7,113,297	5,069,847
Other:		
Government of Canada and Provincial bonds, at cost (approximate market value: 1982 $8,933; 1981 $8,376)	10,000	10,000
Patents, at nominal value (Note 2)	101	75
	10,101	10,075
Fixed:		
Equipment (Note 4)	15,157,087	11,449,468
	22,280,485	16,529,390
Trust Fund:		
Deposits in trust (Note 3)	792,975	1,232,954
Equipment (Note 4)	989,200	722,166
	1,782,175	1,955,120
Total	$24,062,660	$18,484,510

Liabilities and Surplus

	1982	1981
Current:		
Accounts payable	$ 4,069,536	$ 2,448,219
Advances payable, Province of Alberta	167,013	140,596
	4,236,549	2,588,815
Equity:		
Operating surplus, Statement B	2,886,849	2,491,107
Capital surplus	15,157,087	11,449,468
	18,043,936	13,940,575
	22,280,485	16,529,390
Trust Fund:		
Trust liability, Statement C	1,649,541	1,819,713
Accounts payable	132,634	135,407
	1,782,175	1,955,120
Total	$24,062,660	$18,484,510

STATEMENT B

ALBERTA RESEARCH COUNCIL
STATEMENT OF REVENUE, EXPENDITURE AND OPERATING SURPLUS
FOR THE YEAR ENDED MARCH 31, 1982

Revenue	1982	1981
Grant from Province of Alberta, Department of Executive Council	$15,000,000	$11,561,000
Contract revenue	14,978,504	10,335,122
Other income	312,767	319,190
	30,291,271	22,215,312
Expenditure		
Executive offices	923,141	1,336,068
Administration division	2,850,951	2,481,697
Energy resources division	9,549,995	6,321,704
Frontier sciences division	2,765,278	2,087,468
Natural resources division	9,503,690	6,895,341
Industrial and engineering research division	4,302,474	3,379,707
	29,895,529	22,501,985
Excess of revenue over expenditure for the year	395,742	(286,673)
Operating surplus at beginning of year	2,491,107	2,777,780
Operating surplus at end of year	$ 2,886,849	$ 2,491,107

STATEMENT C

ALBERTA RESEARCH COUNCIL
STATEMENT OF TRUST FUND TRANSACTIONS
FOR THE YEAR ENDED MARCH 31, 1982

	Balance at Beginning of Year	Contributions and Additions	Expenditure and Disposals	Balance at March 31, 1982	1981
Agency agreements	$1,097,547	$2,693,229	$(3,130,435)	$ 660,341	$1,097,547
Equipment	722,166	267,034	—	989,200	722,166
Total trust fund	$1,819,713	$2,960,263	$(3,130,435)	$1,649,541	
1981	$ 723,877	$3,071,965	$(1,976,129)		$1,819,713

The accompanying notes are part of these financial statements.

ALBERTA RESEARCH COUNCIL
NOTES TO THE FINANCIAL STATEMENTS
MARCH 31, 1982

Note 1
Authority

The Alberta Research Council operates under the authority of the Alberta Research Council Act, Chapter A 35.1, Statutes of Alberta 1981.

Note 2
Summary of Significant Accounting Policies and Reporting Practices

(a) General: These financial statements have been prepared in accordance with generally accepted accounting principles except that no provision for depreciation on fixed assets has been made. Purchases of operating fixed assets are charged to operations in the year and items costing in excess of $500 are shown on the balance sheet at original cost with the offsetting credit to capital surplus.

(b) Trust Fund: Trust funds are amounts held under agency agreements which specify that the Council administer the funds and provide accounting services.

(c) Administration Expenses: Accommodation and office furniture have been provided by the Province of Alberta at no cost and are not reflected in these financial statements.

(d) Patents: Expenditures for patents owned by the Council as a result of research activity are not capitalized due to the intangible nature of assets that may accrue to the Council.

(e) Investments: The Council has become an equity participant in external organizations as a result of conducting certain research activities. The Council's equity in these external organizations is not material and is therefore not reflected in these financial statements.

(f) Changes in Financial Position: A statement of changes in financial position is not provided as disclosure in these financial statements is considered to be adequate.

Note 3
Deposits in Trust

Deposits in trust consist of amounts held in the General Trust Fund of the Province of Alberta.

Note 4
Fixed Assets

During the 1979-80 fiscal year the Council commenced to account for fixed assets previously acquired. Those assets accounted for have been recorded mainly at estimated acquisition cost. Fixed assets purchased after March 31, 1979 have been recorded at cost.

	Fixed Assets	Fixed Assets - Trust
Assets at March 31, 1979 mainly at estimated acquisition cost	$ 7,699,505	$193,460
Subsequent additions at cost	7,487,582	795,740
	$15,157,087	$989,200

Note 5
Approval of Financial Statements

These financial statements were approved by management on November 8, 1982.

Board of Directors

MR. E.C. MUSGREAVE * (Chairman)
Member of the Legislative Assembly

THE HONORABLE H. PLANCHE
Minister of Economic Development

THE HONORABLE J.W. COOKSON, (retired Nov. 2, 1982)
Minister of the Environment

THE HONORABLE D. JOHNSTON, (appointed Dec. 15, 1982)
Minister of Advanced Education

DR. C.W. BOWMAN,
Chairman, Alberta Oil Sands Technology and Research Authority, Edmonton

MR. B.W. BROOKER, P.Eng.*
President, B.W. Brooker Engineering Ltd., Edmonton

DR. K.E. COOPER,
Vice-President, (Research), University of Calgary, Calgary

DR. J. FORSTER, (deceased)
Dean of Graduate Studies and Research, University of Alberta, Edmonton

DR. R.M. HARDY, P.Eng.
Chairman of the Board, Hardy Associates (1978) Ltd., Edmonton

MR. J.H. NODWELL*,
President, Canadian Foremost Ltd., Calgary

MR. J.E. PIKE*
Retired Businessman, Wetaskiwin

DR. D.R. STANLEY*
President, Stanley Associates Engineering Ltd., Edmonton

MR. A.F. TOTTRUP, P.Eng.*
President, Oil Recovery Engineering Ltd., Edmonton

MR. M.M. WILLIAMS,
President and Chief Executive Officer, TransAlta Utilities Corporation, Calgary

DR. G.G. CLOUTIER*
President, Alberta Research Council, Edmonton

*Executive Committee

Salary Schedule Advisory Committee

DR. G.G. CLOUTIER (Chairman)
President, Alberta Research Council, Edmonton

DR. K.E. COOPER
Vice-President (Research), University of Calgary, Calgary

DR. R.M. HARDY, P.Eng.
Chairman of the Board, Hardy Associates (1978) Ltd., Edmonton

MR. M.M. WILLIAMS
President and Chief Executive Officer, TransAlta Utilities Corporation, Calgary

Senior Management Staff

DR. G.G. CLOUTIER President	Terrace Plaza
DR. R. GREEN Director, Policy Development and Program Evaluation	Terrace Plaza
DR. H.W. HABGOOD Special Assistant, University Liaison	Terrace Plaza
MRS. D.M. HOLLANDS Secretary of Council	Terrace Plaza
DR. E.A. BABCOCK Director, Natural Resources Division	Terrace Plaza
MR. W.J. CHERPETA Director, Finance & Administration Division	Terrace Plaza
DR. D.J. CURRIE Director, Frontier Sciences Division	Campus Building
DR. J.G. DOUGLAS Director, Energy Resources Division	Terrace Plaza
DR. D.L. MITCHELL Director, Industrial and Engineering Division	Terrace Plaza

The Executive Offices are located at
7th floor, Terrace Plaza
4445 Calgary Trail South
Edmonton, Alberta
Canada, T6H 5R7

Staff of the Alberta Research Council, 1982

Executive Offices

President's Office

President: GILLES G. CLOUTIER, O.C., Ph.D. (McGill). *Terrace Plaza*
Secretary to the President: J.A. BOOTH, B.Ed. (Alberta)
Support Staff: D.G. ALLEN.

Secretariat

Secretary of Council: D.M. HOLLANDS. *Terrace Plaza*
Professional Staff: P.F. ROAF, B.J. (Carleton); C. CLARKE, B.J. (Carleton).
Support Staff: M.L. LIMOGES.
Secretarial Staff: T.V. KURELUK.

Policy Development and Program Evaluation

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Secretarial Staff: S.V. STADLER.

Liaison with Universities and other Institutions

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Secretarial Staff: D.M. PARK.

Office of Science and Technology

Director: A. VANTERPOOL, Ph.D. (Cambridge). *Terrace Plaza*

Industrial and Engineering Research Division

Director: D.L. MITCHELL, Ph.D. (Queen's). *Terrace Plaza*
Secretarial Staff: M. MILES.
Support Staff: K. CYMBALA.

Program Development Group

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Support Staff: M. SUSTRIK.

Industrial Development

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Technical Staff: F. BOTI; R.E. GREGORY; M.E. HART; W. MACQUARRIE, B.Sc. (Alberta); T. MAUBERT, B.A. (Calgary); D.D. WASCHEROL; S.I. WEST; B. ZEZULKA.
Support Staff: R. BROWN; D. HNATKO; H. LEURY; N.A. LUCK; E. WAGENSEIL.

Civil Engineering

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Technical Staff: R. BILYK; L.M. CHASE; G.D. LEGGE; T. LILIENTHAL, B.Sc. (Dalhousie); P.E. MOSTERT; T.P. RIDGWAY; W.J. SADOWAY; J.H. THOMPSON; B. TREVOR.
Support Staff: A.E. ELLENDT; J.L. MERRITHEW.

Chemical and Materials Engineering

Head: A.A. ROEHL, B.Sc. (Alberta). *Parson's Warehouse*
Managers: L. BACH, Ph.D. (Syracuse); G. STOTT, B.Sc. (Alberta).
Professional Staff: E.F. BERTRAM, Ph.D. (Illinois); G. ELYAS, M.Sc. (Strathclyde); W.C. KAY, B.Sc. (Alberta); C.Y. PAN, Ph.D. (Toronto); T.W. RACHUK, Ph.D. (Alberta); R. RANSOM, B.Sc. (Carleton); R.W. WASEL, B.Sc. (Alberta); B. WYSLOUZIL, B.Sc. (Queen's).
Technical Staff: S. BARNETT; M.L. BLACHUT; K. BRENCHLEY; I. ERDEBIL; E.M. HADFIELD; E.J. JACKSON; K. PATTISON; B.K. REBUS, B.Sc. (Alberta); R.A. ROSE; R.J. SALAZYN; D.A. WISPINSKI.
Support Staff: S.N. BARSALOUX; S. SINGH; J. WYNN.

Mechanical and Electrical Engineering

Head: Vacant. *Terrace Plaza*
Manager: B. LUFT, Ph.D. (Alberta).
Professional Staff: D. BAKER, B.Sc. (Alberta); G. HOWELL, B.Sc. (Alberta).
Machine Shop
Supervisor: S.W. HOLLEMEYER. *Parson's Warehouse*
Technical Staff: M. BANOVICH; G. BERLINGO; V. CELINO; M. DANYSH; A.R. EWANCHUK; C. KORTH; B.R. LAYDON; D. McALPINE.
Instrument Repair
Supervisor: J.A. KINASEWICH. *Campus Building*
Technical Staff: K. CROFT; J.J. YOUNG.

Frontier Sciences Division

Director: D.J. CURRIE, Ph.D. (Leeds). *Campus Building*
Secretarial Staff: D.L. JACKSON.
Support Staff: L.K. MUMA.

Chemistry

Head: M.A. KESSICK, Ph.D. (London). *Campus Building*
Research Fellow: R.M. ELOFSON, Ph.D. (Wisconsin).
Professional Staff: A.T. BLADES, Ph.D. (Wisconsin); N. CYR, Ph.D. (British Columbia); F.F. GADALLAH, B.Sc. (Cairo); Z.M. GEORGE, Ph.D. (McGill); J.M.L. GRAY, Ph.D. (Colorado); R.F. KLEMM, Ph.D. (Michigan); A. MAR, M.Sc. (McGill); R.S. McDANIEL, Ph.D. (Simon Fraser); C.F. RICHMOND, B.Sc. (California); A.R. SANGER, D.Phil. (Sussex); L.G. SCHNEIDER, B.Sc. (Alberta); K.F. SCHULZ, Ph.D. (Zagreb); R.W. TOWER, M.Sc. (Moncton); K. TREMAINE, B.Sc. (Manitoba); M. WORSLEY, Ph.D. (Toronto).
Visiting Scientist: B. BEYER, Ph.D. (Michigan).
Technical Staff: S.G. ARMSTRONG; R.V. ERB; T. FREEMAN; C.M. GOULET; J.K. LAIDLER; P.T. MOHAMMED, B.Sc. (Alberta); J.R. NELSON, B.Sc. (Alberta); E.H. ONDERKA-LECLAIR; T.M. PAINTER; M.D. RAWLUK; L.R. SCHALLIG; M.M. SCHUREK; R. VAN ENGELEN; W.K. WADE, B.Sc. (Alberta); E.V. ZACHARUK.
Support Staff: B.L. TURNER.

Biology Group

Head: T. KANEDA, D.Sc. (Tokyo). *Campus Building*
Professional Staff: D.R. BOONE, Ph.D. (Florida); S.C. CHEN, Ph.D. (Simon Fraser); W.T. LEPS, Ph.D. (Wisconsin); J. WOHLLEBE, B.Sc. (Erlangen).
Visiting Scientists: N. MURAZUMI, Ph.D. (Hokkaido); T. SHIMADA, Ph.D. (Kyoto).
Technical Staff: M.A. BRANDINGEN; I. GOVAN; A.S. GREEN; J.M. MACTAGGART, B.Sc. (Regina); J. YU.
Support Staff: G. FERRACUTI.

Computing

Acting Manager: P.J. REDBERGER, B.Sc. (Moravian College). *Campus Building*
Professional Staff: A. BARDAI, B.Sc. (Calgary); A.R. COVINGTON, M.Sc. (Alberta); D CUTHIELL, Ph.D. (Cornell); W.J. NEILSON, M.Sc. (Alberta).
Technical Staff: R.P. ERKAMP.

Energy Resources Division

Director: J.G. DOUGLAS, Ph.D. (London). *Terrace Plaza*
Secretarial Staff: L.F. FRANCIS.

Oil Sands Research

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